

output is reduced. This problem could be overcome by increasing the sheet resistance of the spin valve film. In an ordinary SyAF-type pinned layer, the thickness of the pinned layer is larger than a conventional, single-layered pinned magnetic layer. Therefore, increasing the sheet resistance of the spin valve film having such an ordinary SyAF-type pinned layer is difficult. However, as in Table 14 and Table 15, since the sum total of the thicknesses of the pinned magnetic layer, the nonmagnetic spacer layer and the free layer is limited to at most 14 nanometers in the invention, both high sheet resistance of at least  $16 \Omega$  and high resistance change rate of at least 8 % could be attained.

Table 14

Spin Valve Film Constitution:

5 nanometer Ta/2nm Au/7 nm IrMn/ferromagnetic layer

B/antiferromagnetically coupling layer/ferromagnetic layer

A/nonmagnetic spacer layer/free layer/Ta

Thickness of Ferromagnetic Layer B (nm)	Thickness of Coupling Layer (nm)	Thickness of Ferromagnetic Layer A (nm)	Thickness of Nonmagnetic spacer layer (nm)	Thickness of Free Layer (nm)	Total Thickness of Ferromagnetic Layer to Free Layer (nm)
2nmCoFe	0.9nmRu	2nmCoFe	2nmCu	0.5nmCoFe/ 2.5nmNiFe	9.9
1.5nmCoFe	0.8nmRu	2nmCoFe	2nmCu	0.5nmCoFe/ 4nmNiFe	10.8
1.5nmCoFe	0.9nmRu	2nmCoFe	2.5nmCu	3nmCoFe	9.9
2nmCoFe	0.9nmRu	2nmCoFe	2nmCu	1nmCo/ 5nmNiFe	12.9
1.5nmCoFe	0.9nmRu	1.5nmCoFe	2nmCu	1nmCo/ 3nmNiFe	9.9
2nmCoFe	0.9nmRu	2.5nmCoFe	2nmCu	3nmCoFe	10.4
2nmCoFe	1nmRu	2.5nmCoFe	2.5nmCu	1nmCo/ 4nmNiFe	13
2.2nmCoFe	0.8nmRu	2.5nmCoFe	2nmCu	2nmCoFe/ 4.5nmNiFe	14
3nmCoFe	0.9nmRu	3nmCoFe	3nmCu	1nmCoFe/ 7nmNiFe	17.8
3nmCoFe	0.9nmRu	3nmCoFe	3nmCu	3nmCoFe/ 2nmNiFe	14.8
2.5nmCoFe	0.8nmRu	3nmCoFe	2.5nmCu	1nmCoFe/ 7nmNiFe	16.8
3nmCoFe	0.7nmRu	3nmCoFe	3nmCu	5nmCoFe	14.7

Table 15

Spin Valve Film Constitution:

5 nanometer Ta/2nm NiFe/7.5 nm PtMn/ferromagnetic layer

B/antiferromagnetically coupling layer/ferromagnetic layer

A/nonmagnetic spacer layer/free layer/Ta

Thickness of Ferromagnetic Layer B (nm)	Thickness of Coupling Layer (nm)	Thickness of Ferromagnetic Layer A (nm)	Thickness of Nonmagnetic spacer layer (nm)	Thickness of Free Layer (nm)	Total Thickness of Ferromagnetic Layer to Free Layer (nm)
2nmCo	0.9nmRu	2nmCo	2.5nmCu	1nmCo/2nmNiFe	10.4
2nmCo	0.9nmRu	2nmCo	2.5nmCu	0.5nmCo/2nmNiFe	9.9
2nmCoFe	0.9nmRu	2nmCoFe	2.5nmCu	1nmCoFe/2nmNiFe	9.7
2nmCoFe	0.9nmRu	2nmCoFe	2.5nmCu	3nmCoFe	10.4